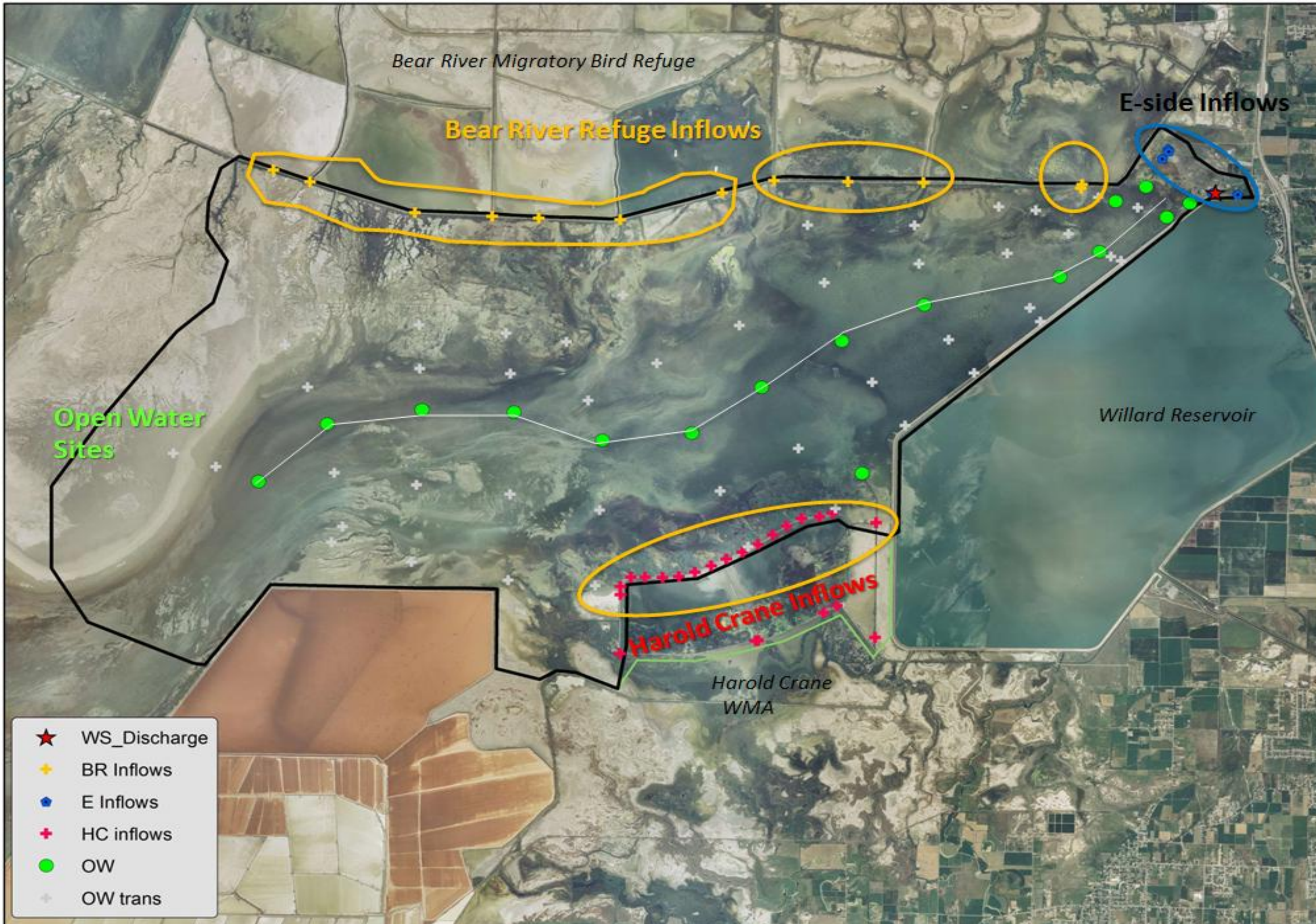
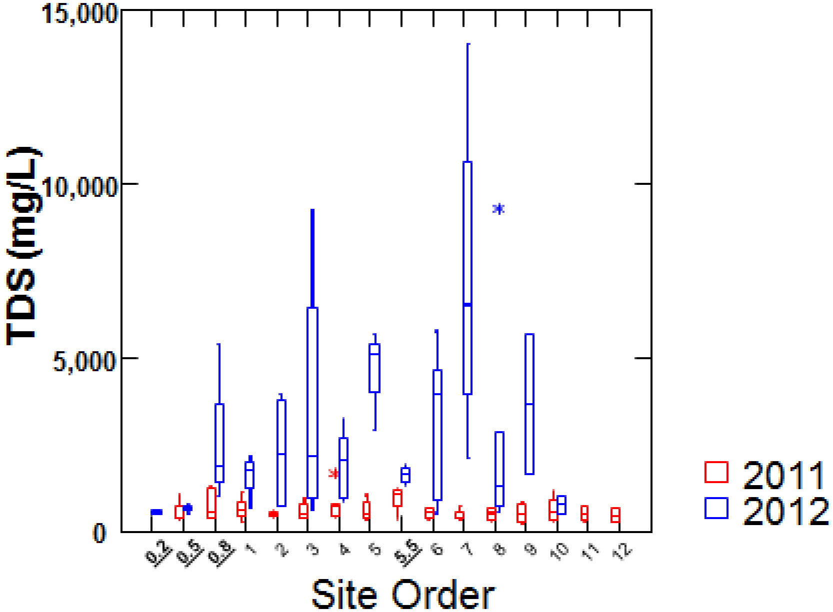
# Willard Spur 2011-12 Monitoring Data & Analyses

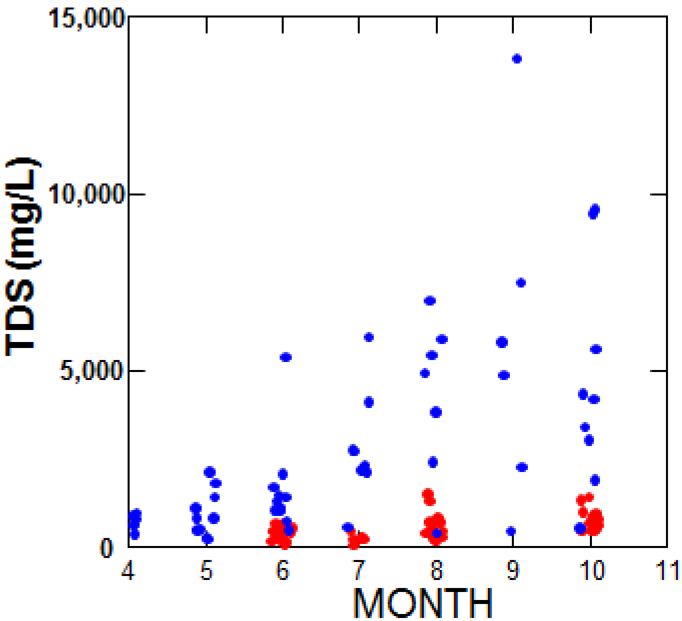
**Utah Division of Water Quality**

# Biogeochemical Patterns and Processes



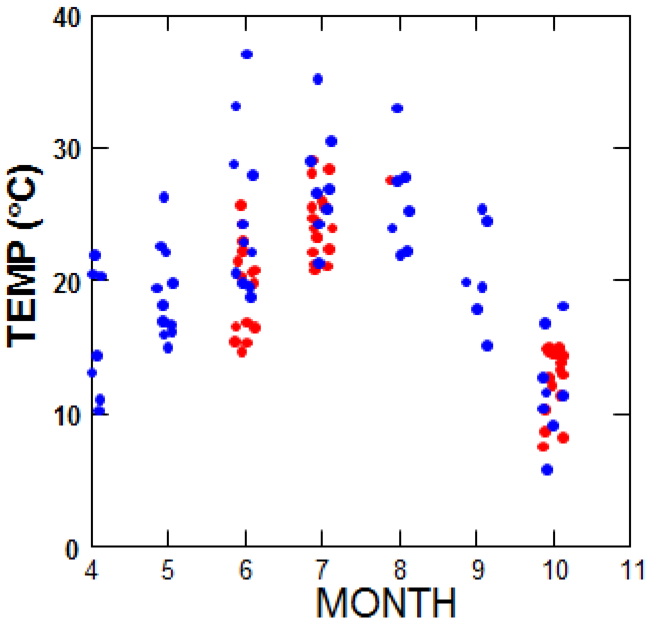
## *1. Salinity and Temperature*




- Higher TDS in 2012 vs. 2011
    - TDS stable throughout 2011
- Largest between-year differences in areas away from *Inflows*
- TDS = 0.595 x EC[25]; $r^2$= 0.99

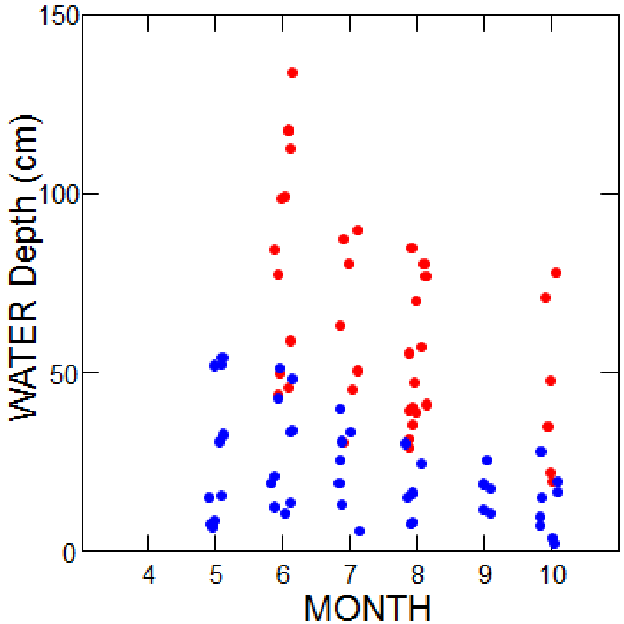
## *1. Salinity and Temperature*

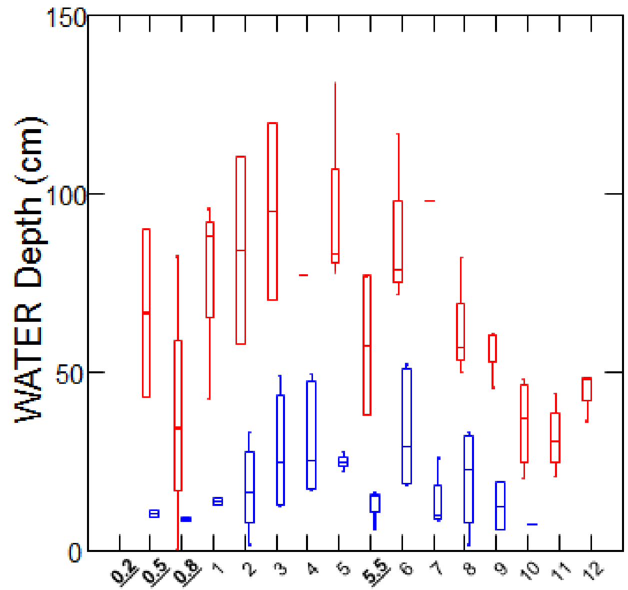



Water Temperature

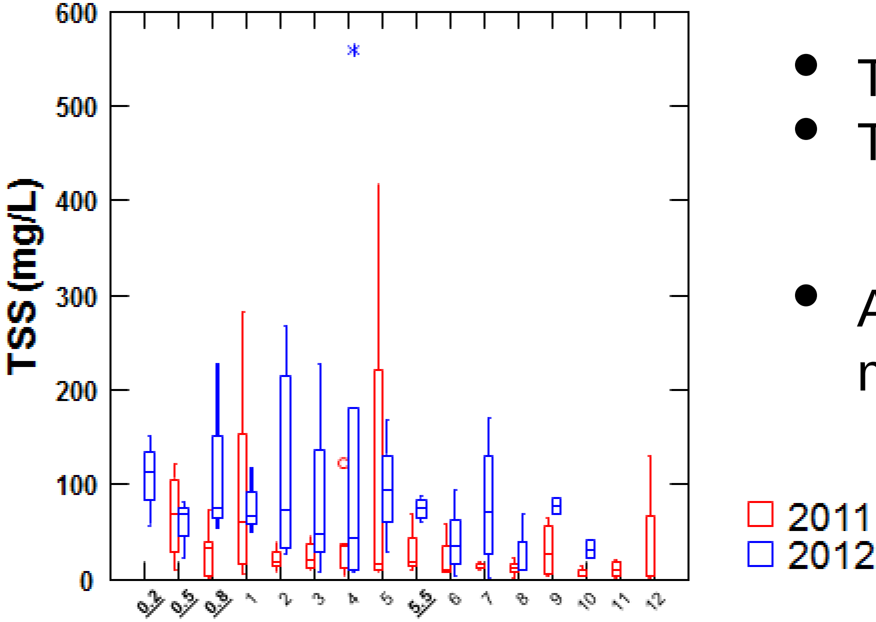
- Commonly higher in 2012 vs 2011
- <u>Expect</u>:
  - Faster rates of biotic growth and nutrient cycling
  - Earlier timing of phenological changes among SAV (more later)?

- Water Depths lower in 2012 vs 2011

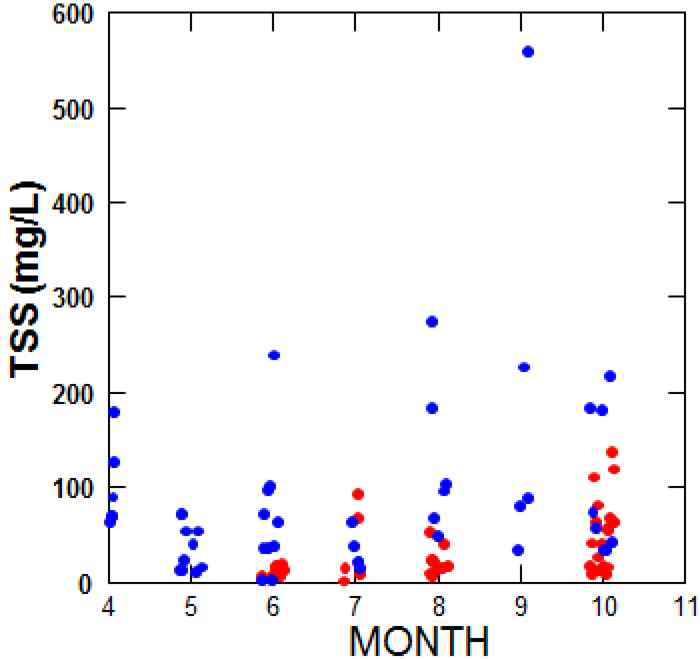


# *2. Water Column - Suspended Solids*

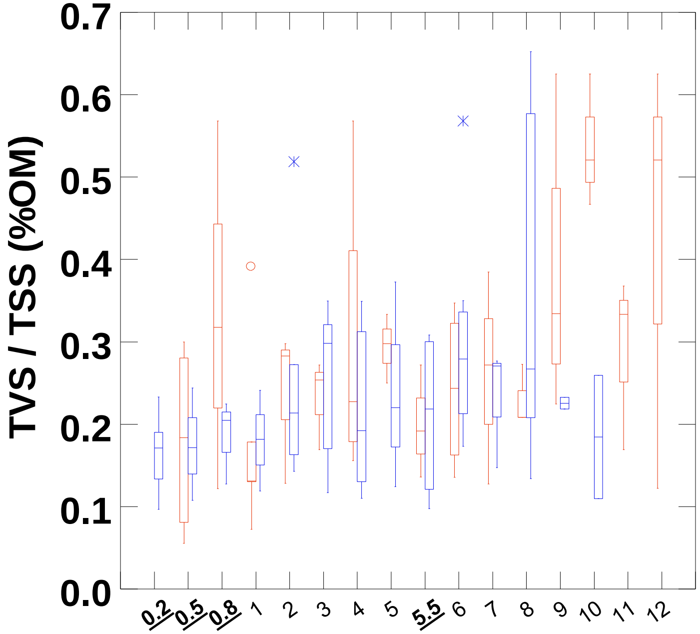


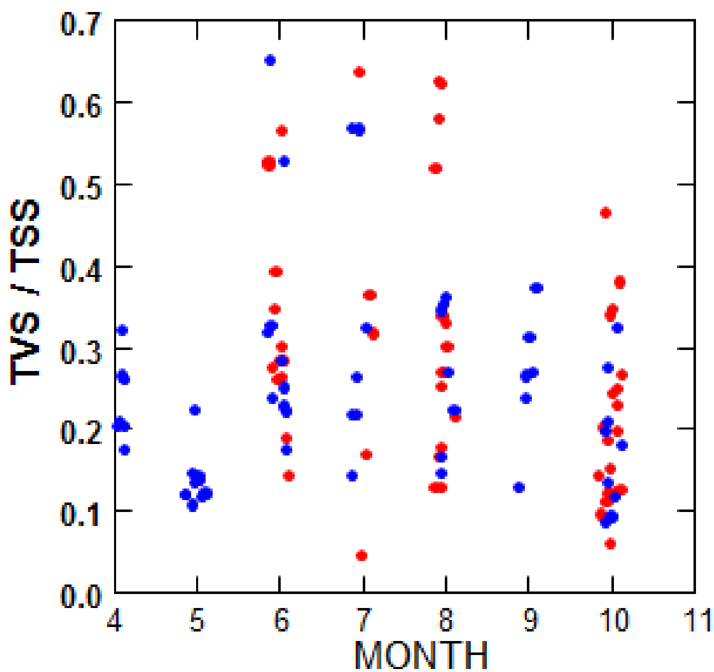

- TSS: 2012 **>** 2011
- TSS highest in *Eastern* OW sites
  - WS-1 to WS-5
- Approximately 17% of TSS is organic matter (as TVS); $r^2 = 0.79$




- Seasonally, highest TSS (> 200 mg/L) observed in late summer - *in 2012 Only*
- <u>TSS Correlations - All data combined</u>:
  - Total-P (+)
  - Particulate organic P (POP) (+)
  - Chl-A (+)
  - TVS (Organic) (+)
  - Organic N (soluble) (+)

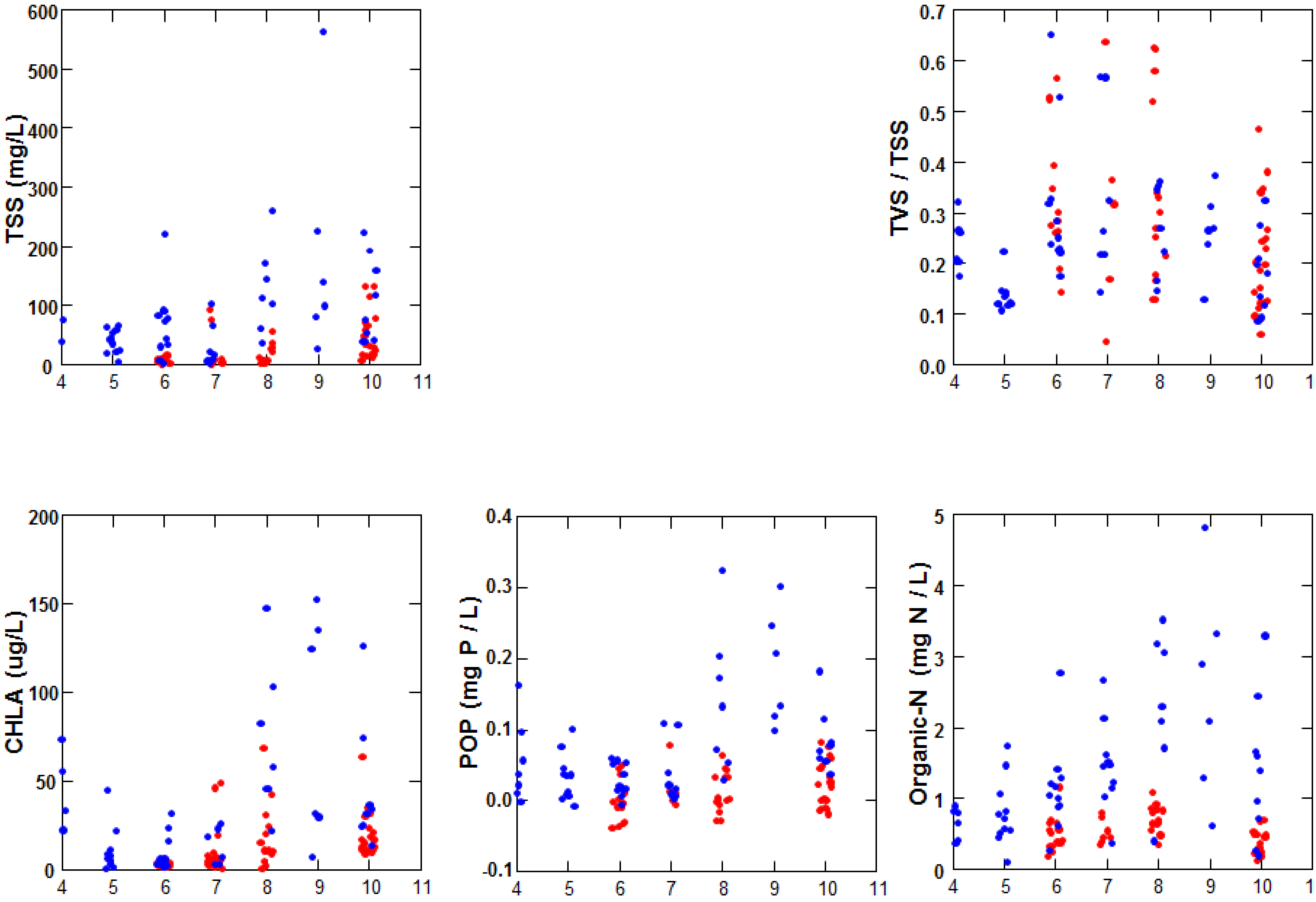
# 2. Water Column - Suspended Solids



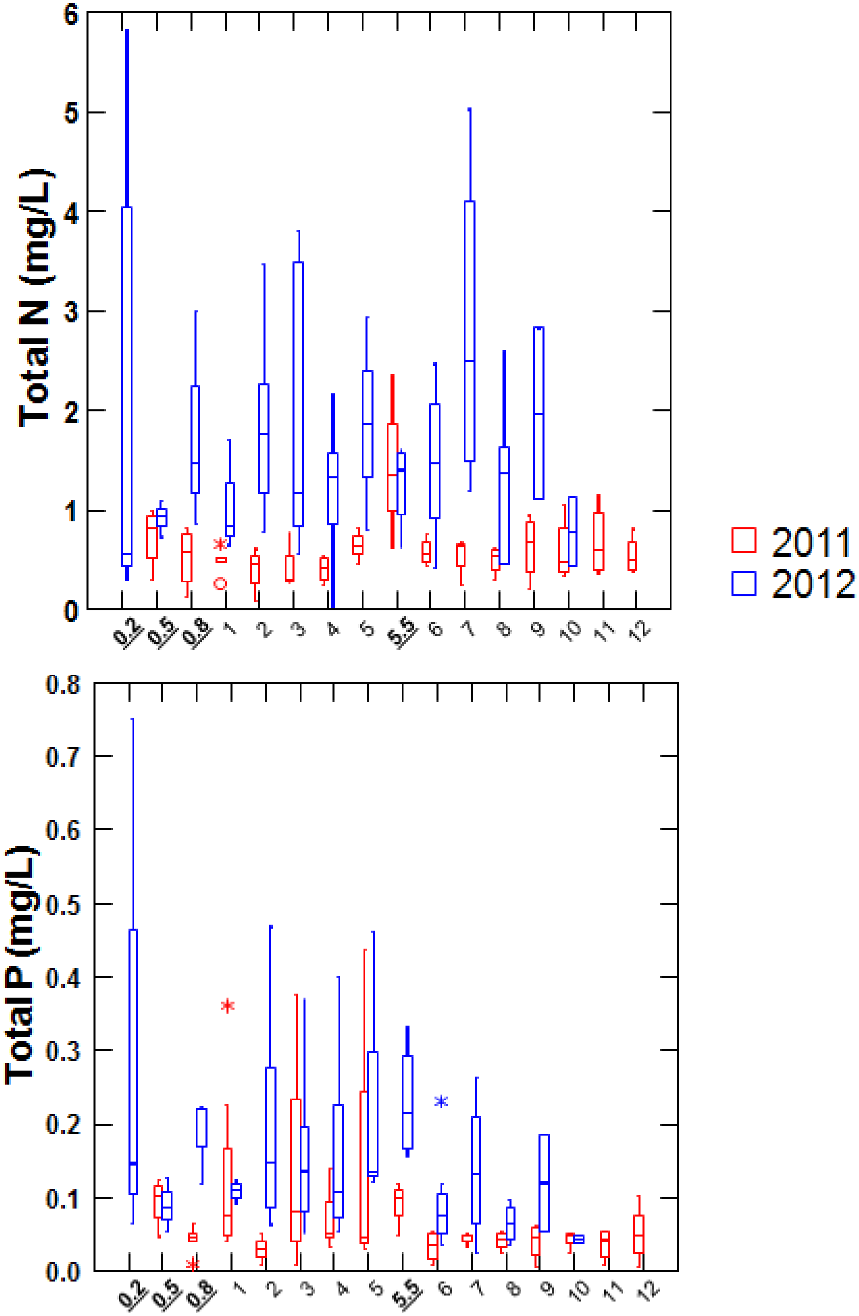




- Ratio of TVS to TSS ==> % Organic Matter of SS
- TVS/TSS tends to <u>*Increase*</u> from East to West
    - Consistent w/ wetland conversion of inorganic to organic constituents
- For some OW sites, TVS/TSS increases to over 50% OM in summer

# 2. Elements of Suspended Solids



# *3. Water Column Nutrient Pools*



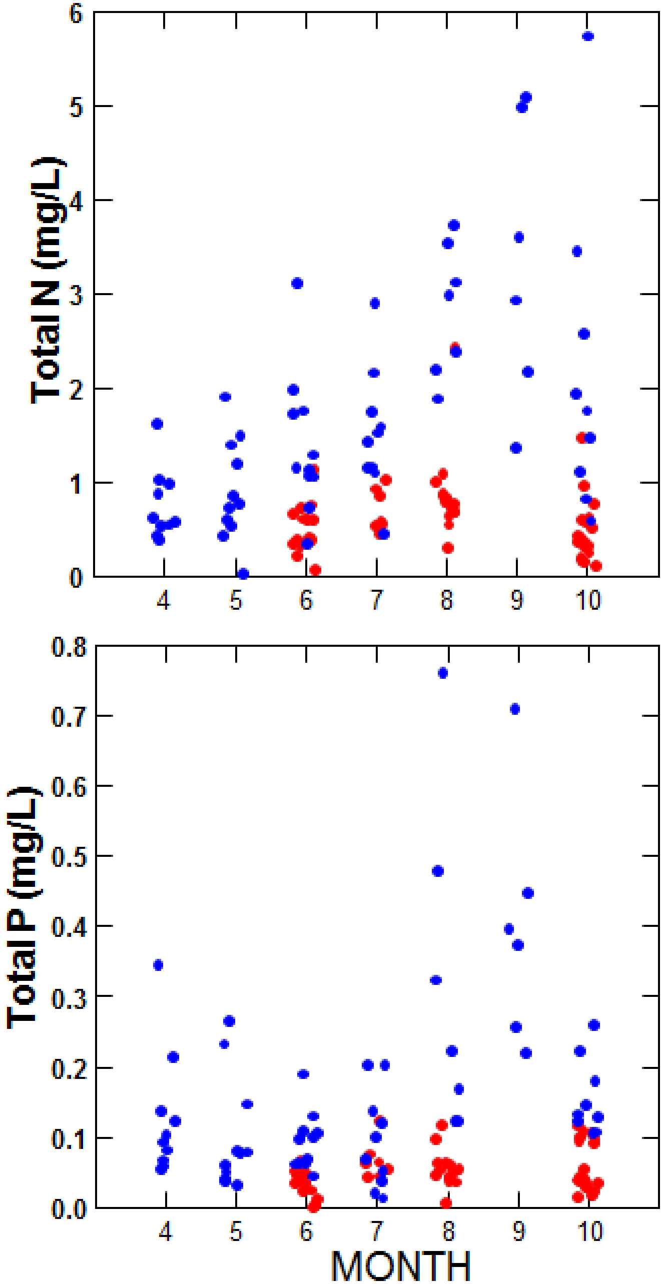

## Total Nutrient Pools

- Total N (TKN + NO3) concentrations greater in 2012 vs. 2011 -- Across Open Water sites

- Total P concentrations *occasionally* greater in 2012 vs 2011 -- Particularly sites near Inflows

- Western-most sites had lowest TN and TP concentrations

# 3. Water Column Nutrient Pools



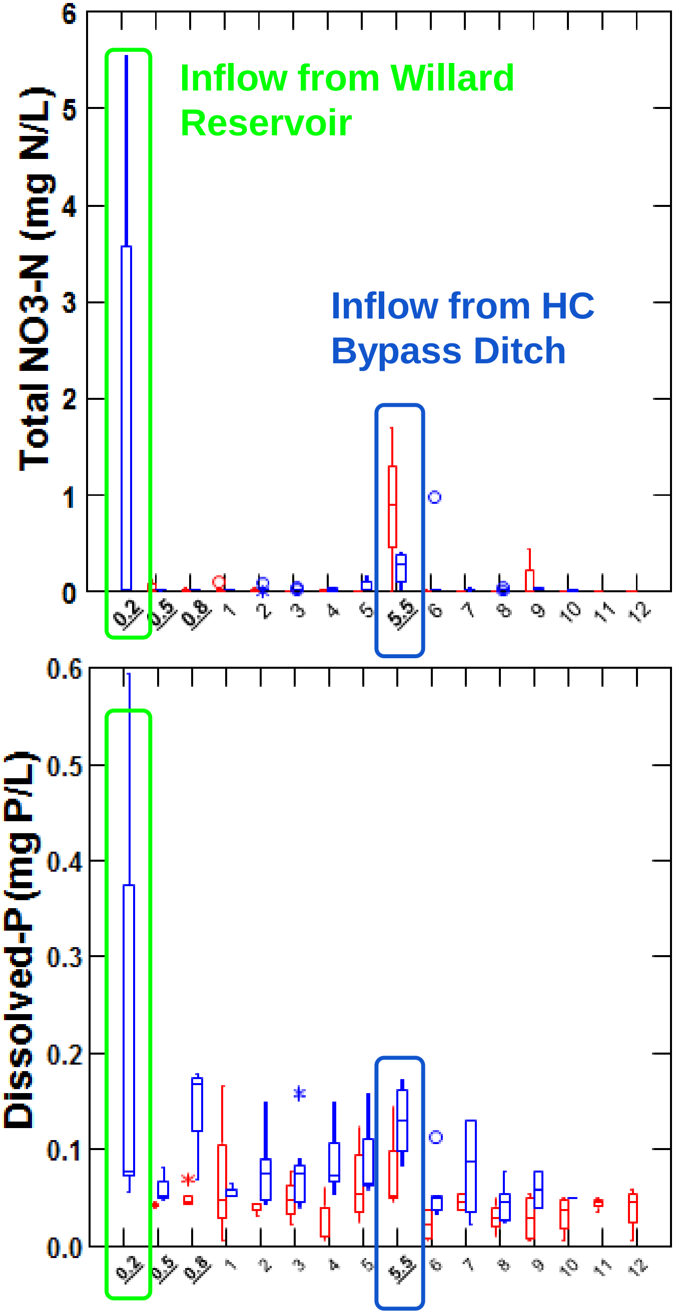

**TN**

- Increased over time in 2012, not 2011
  - Flushing?
- Highest TN concentrations in late summer
- 90%ile:
  - 2011 = 0.88 mg N/L
  - 2012 = 3.18 mg N/L

**TP**

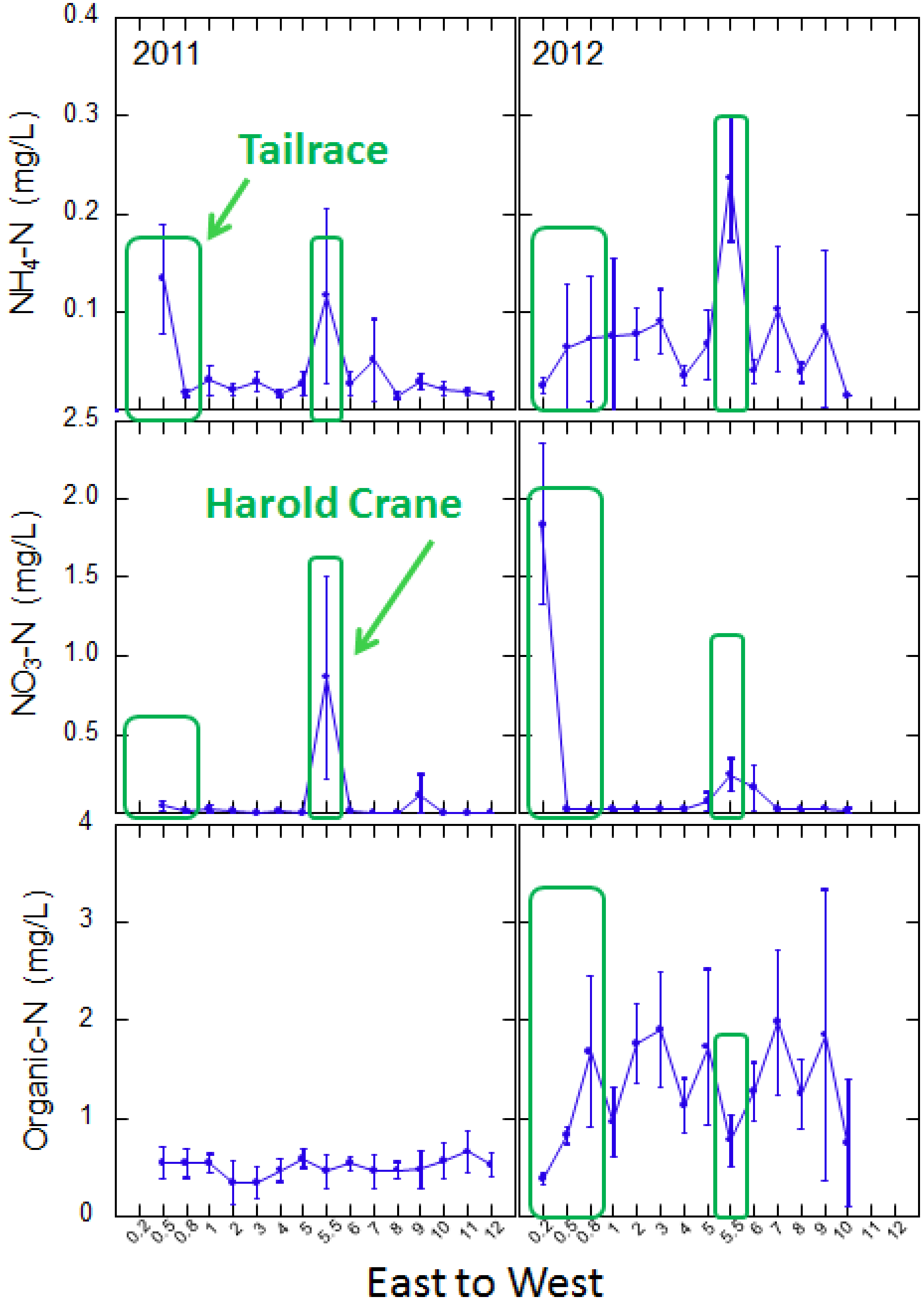
- Increased over time in 2012, not 2011
- 90%ile:
  - 2011 = 0.098 mg P/L
  - 2012 = 0.333 mg P/L

# 3. *Water Column **Dissolved** Nutrient Pools*




- Inorganic N and P pools are generally low
  - Except for sites near inflows

- Given the seasonal increases in TN and TP, this suggests that:
  - Inorganic nutrient cycling is tight (ie that available nutrients are rapidly taken up)
  - ***Nutrient fluxes from inflows are rapidly assimilated within the Open Water sites***




# 3. N Species: Among Sites, Between Years

***Across both years***

- NH4 accounts for 3-5% of Total N
- NO3 accounts for 1-10%
- Organic N accounts for 80-95%

***Values (broadly) higher in 2012 vs 2011, and more variable***

***$NH_4^+$ :***

90%ile 0.133 mg/L (combined)
0.077 [2011]
0.188 [2012]

***$NO_3^-$ :***

90%ile 0.113 mg/L (combined)
0.044 [2011]
0.228 [2012]

***TKN :*** Values for 2012 > 2011

** $NH_4^+$ values < 0.2 mg/L →
*TKN dominated by organic-N*

90%ile 0.857 [2011]
2.97 [2012]

# 4. Pelagic Nutrient Limitation

**Treatments:**

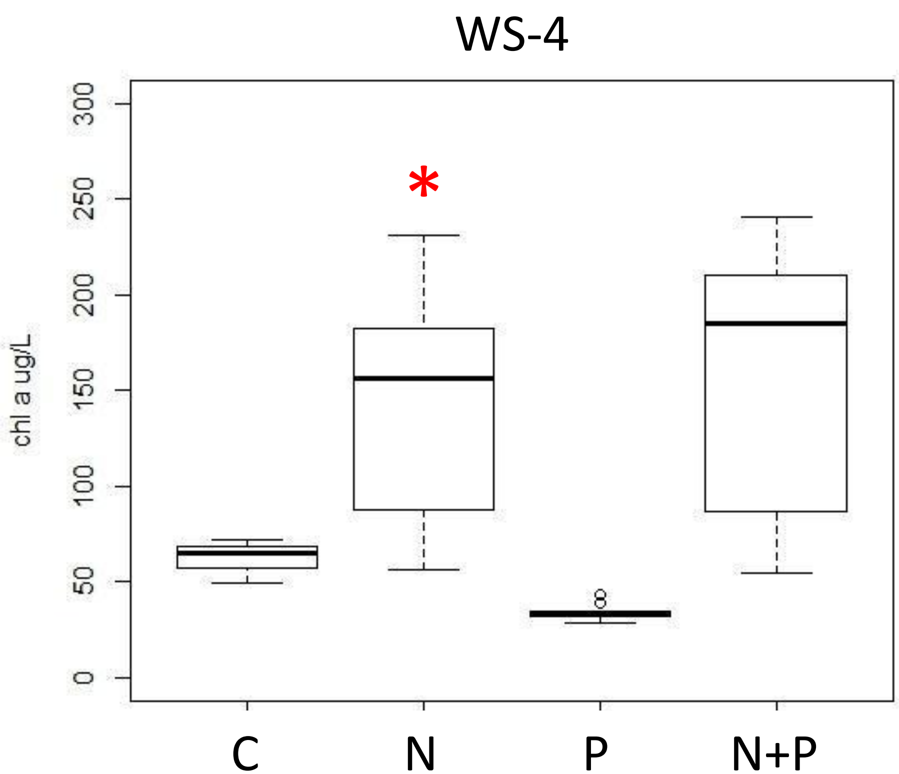
Control

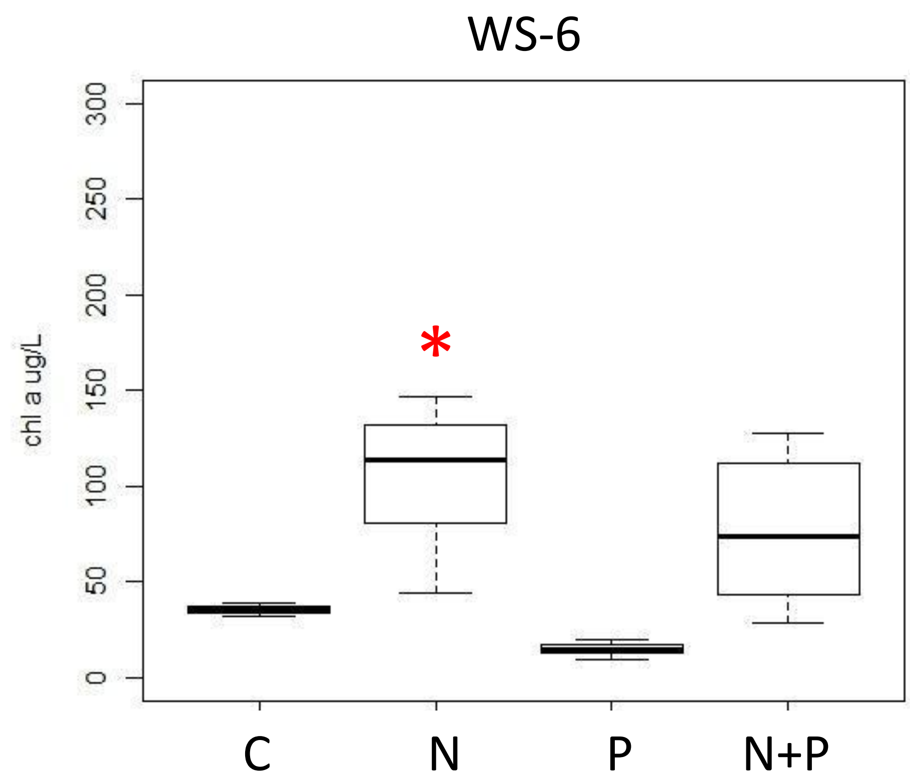
Nitrogen

Phosphorus

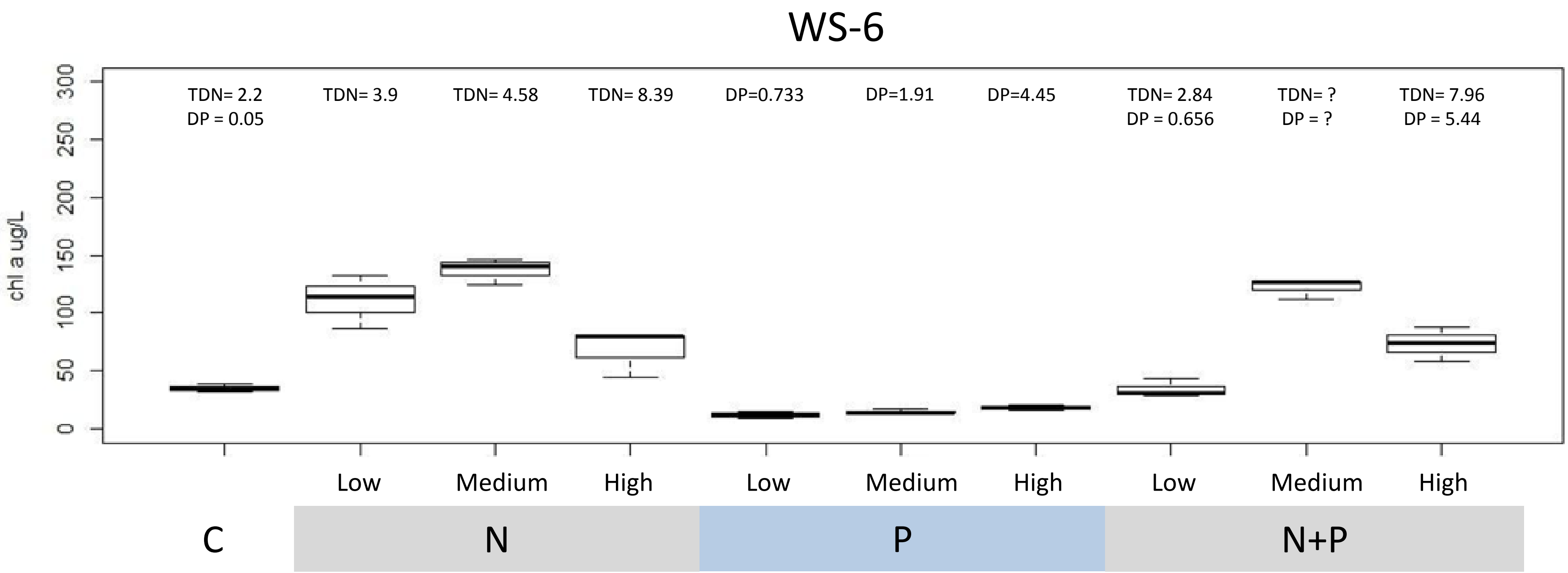
N + P

Low
Medium
High

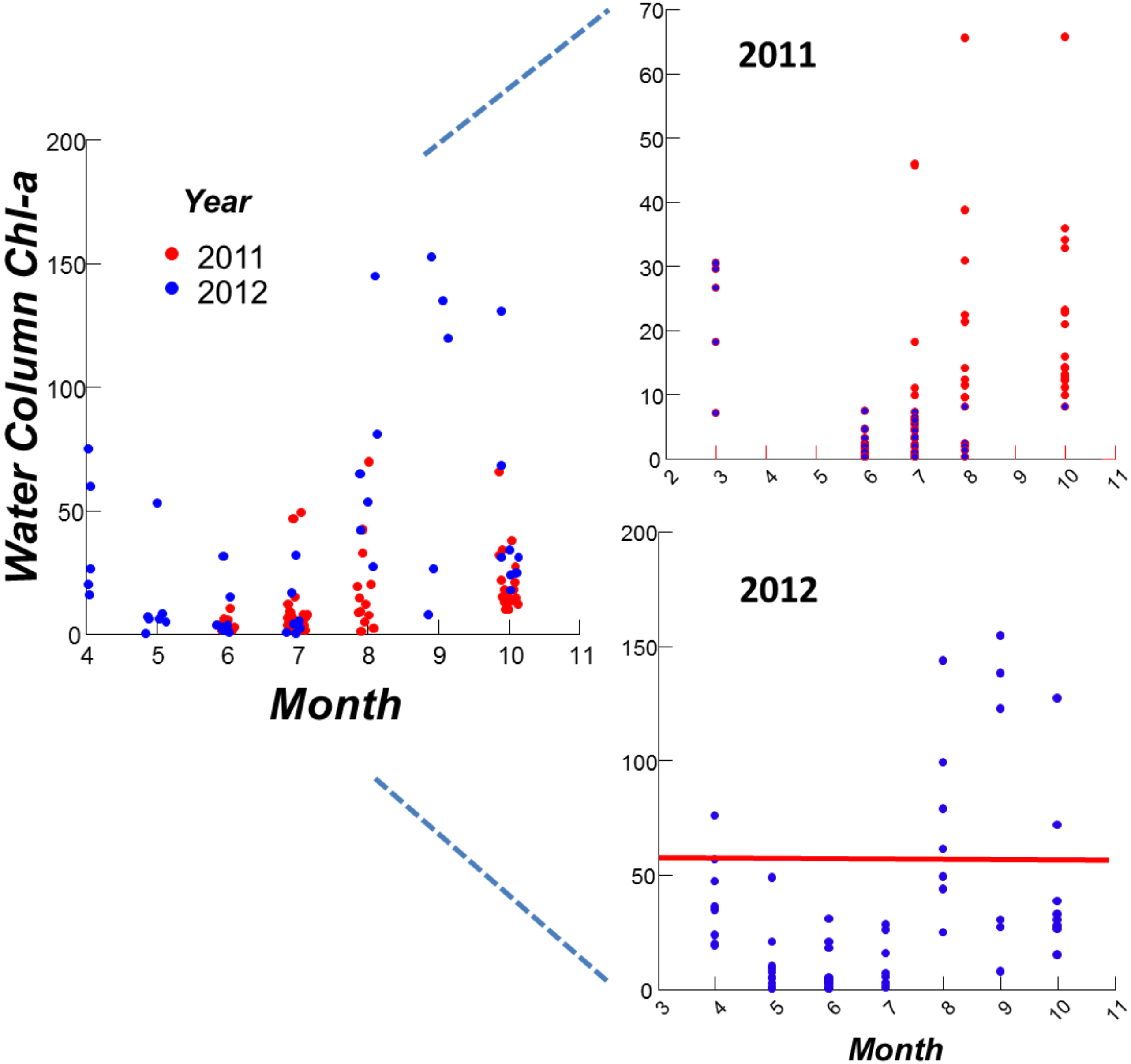

WS-4
chl a ug/L
0
50
100
150
200
250
300
*
C
N
P
N+P


WS-6
chl a ug/L
0
50
100
150
200
250
300
*
C
N
P
N+P

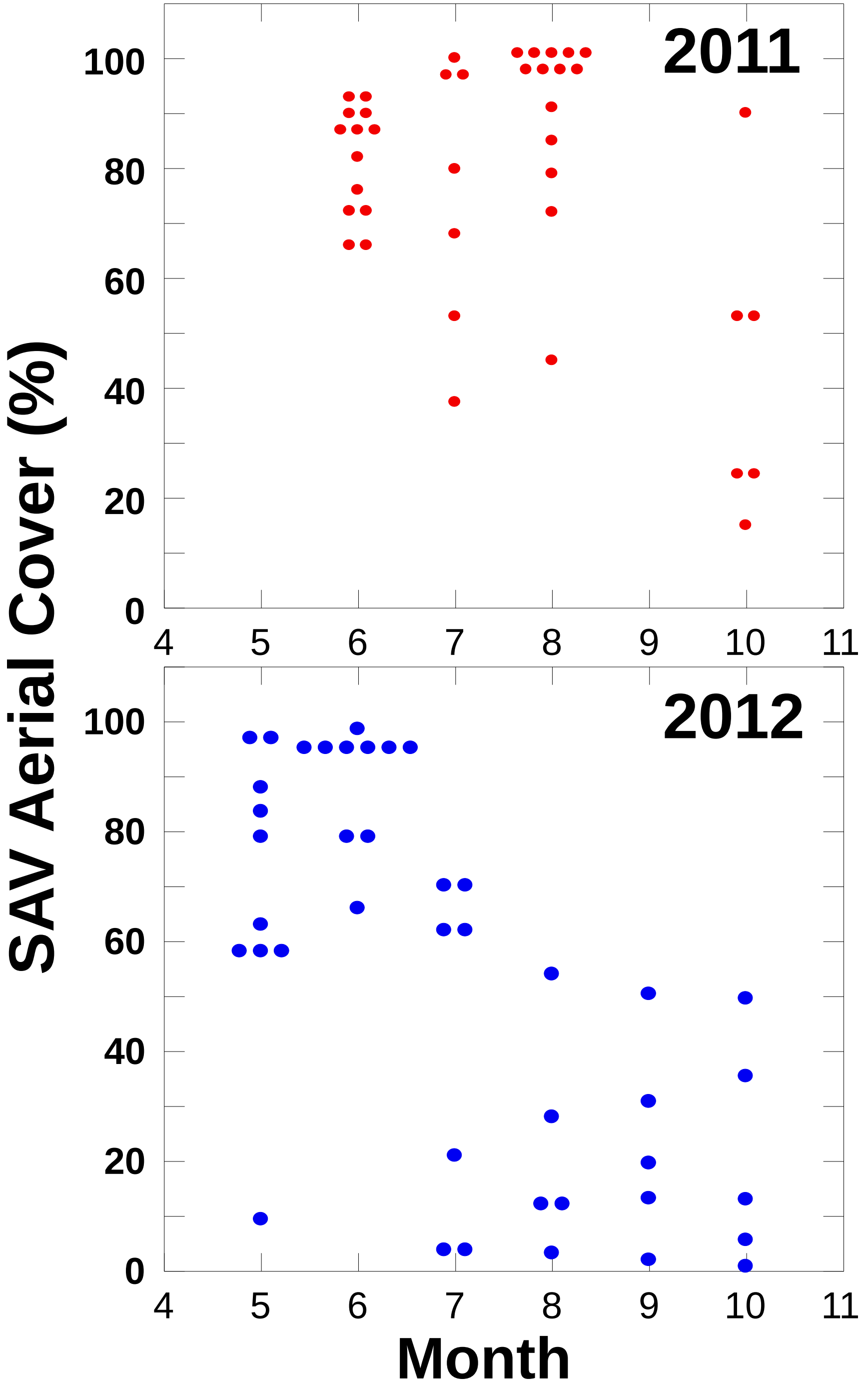
Chl a n=3, for all plots



# 5. Biological Responses



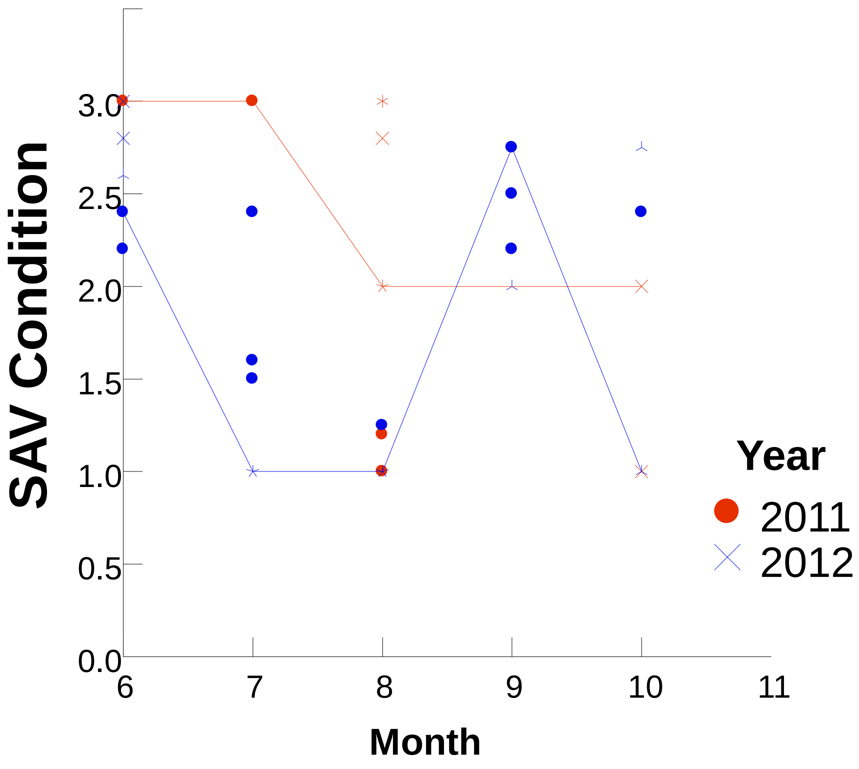

Similar year-to-year pattern, but peaks much higher in 2012




# SAV Cover

- SAV cover was consistently higher, for a longer period of time in 2011 vs. 2012
- In 2012, SAV was pretty hosed by August, yet cover remained high in 2011
- Evidence of SAV senescence when cover is generally <40% among sites?

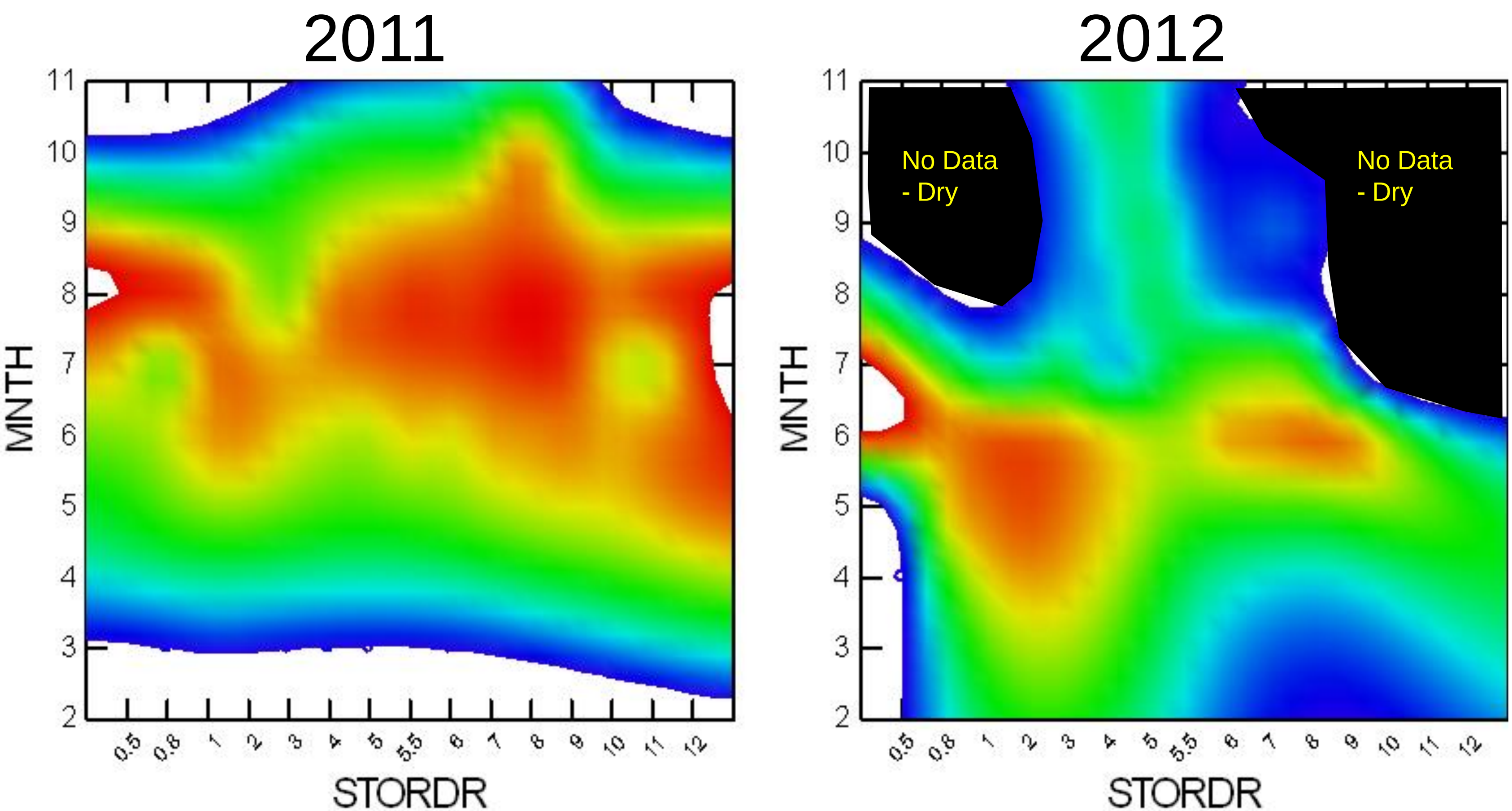
# SAV Condition




- SAV condition was generally higher in 2011, declines were of higher magnitude in 2012

- Average condition declined in July of 2011 and August of 2012

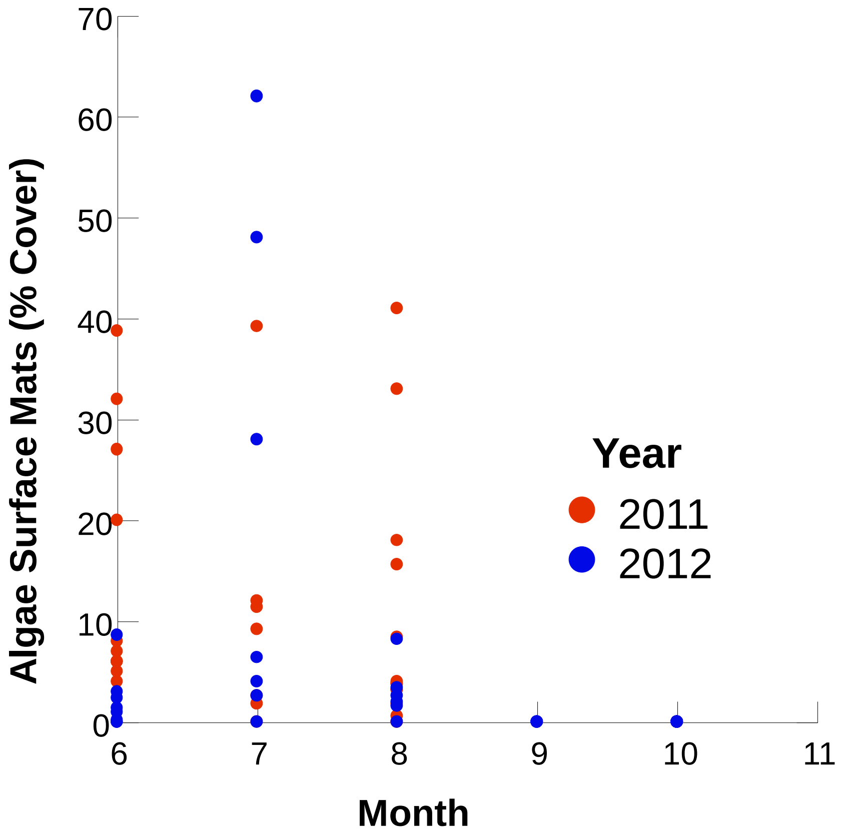
- Recovery in 2012 associated with Coontail emergence?




**Red = High Cover**

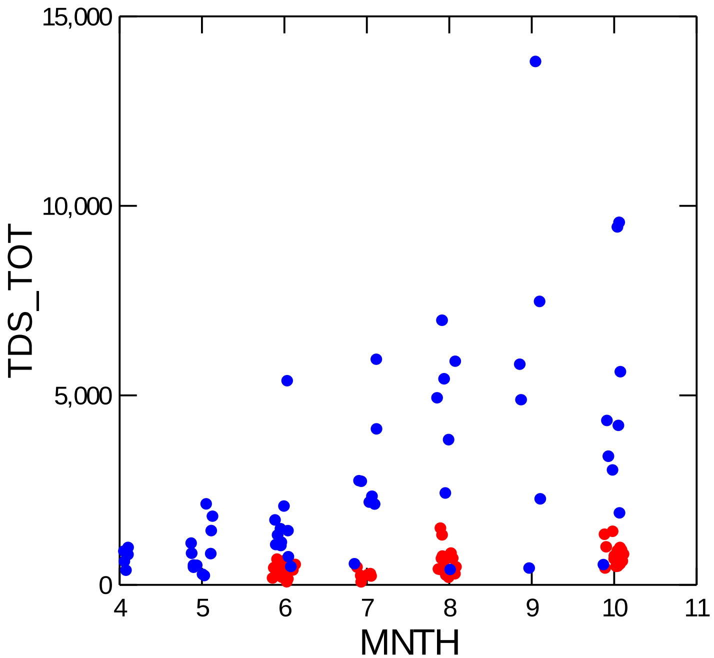
**Blue = Low Cover**

# Algae Surface Mats



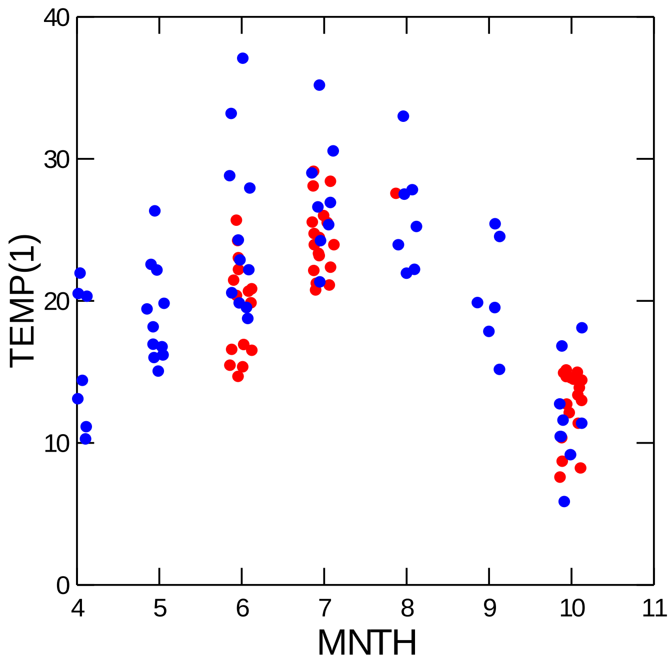

*The absence of evidence is not evidence of absence.*

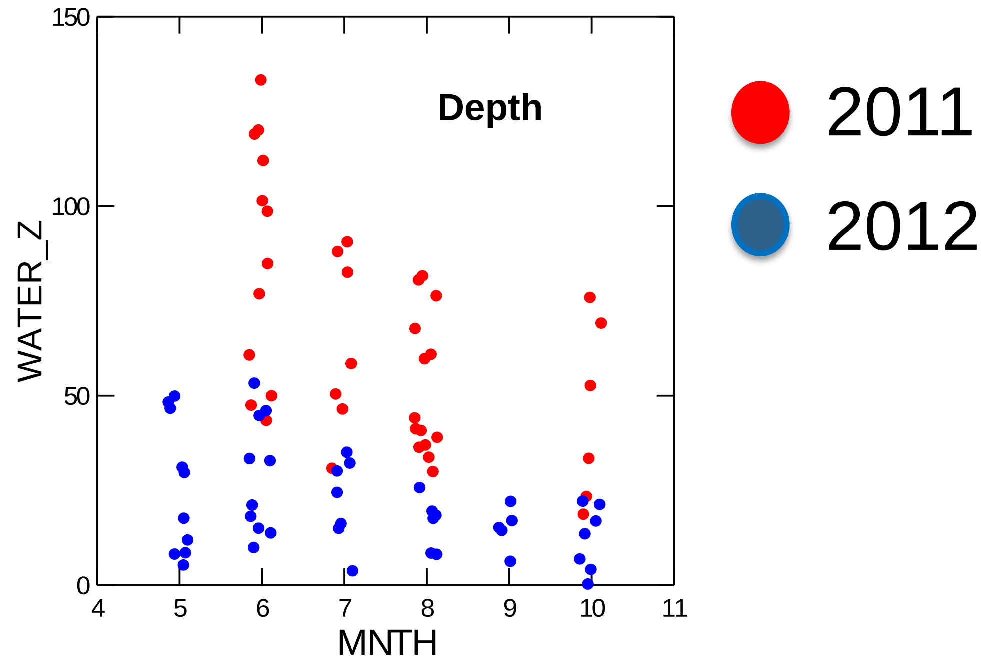
- Site-specific measures may not be reliable, but…
- Many more observations of relatively high algae cover were observed in 2012
- More extensive mats also occurred over a longer period in 2012

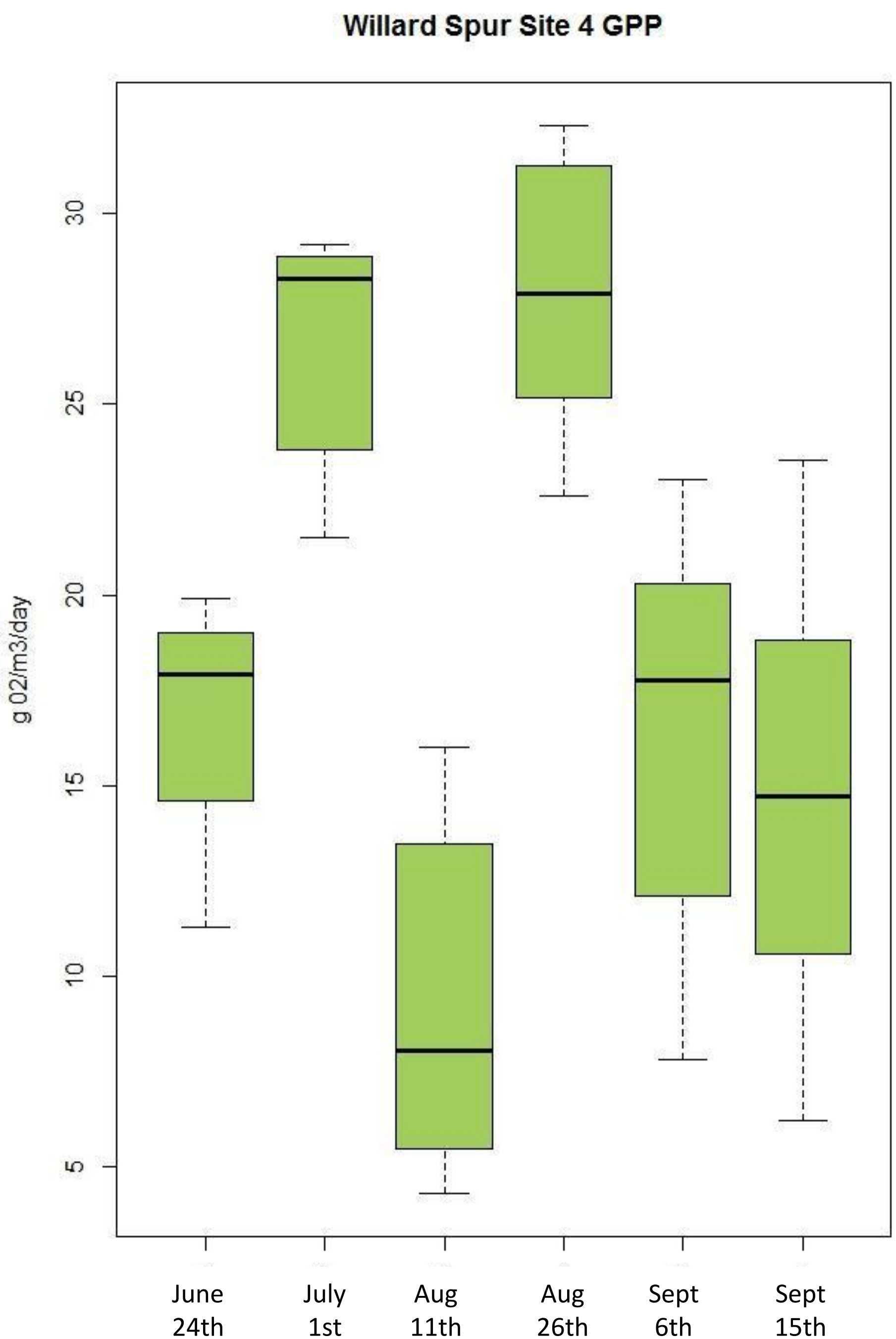


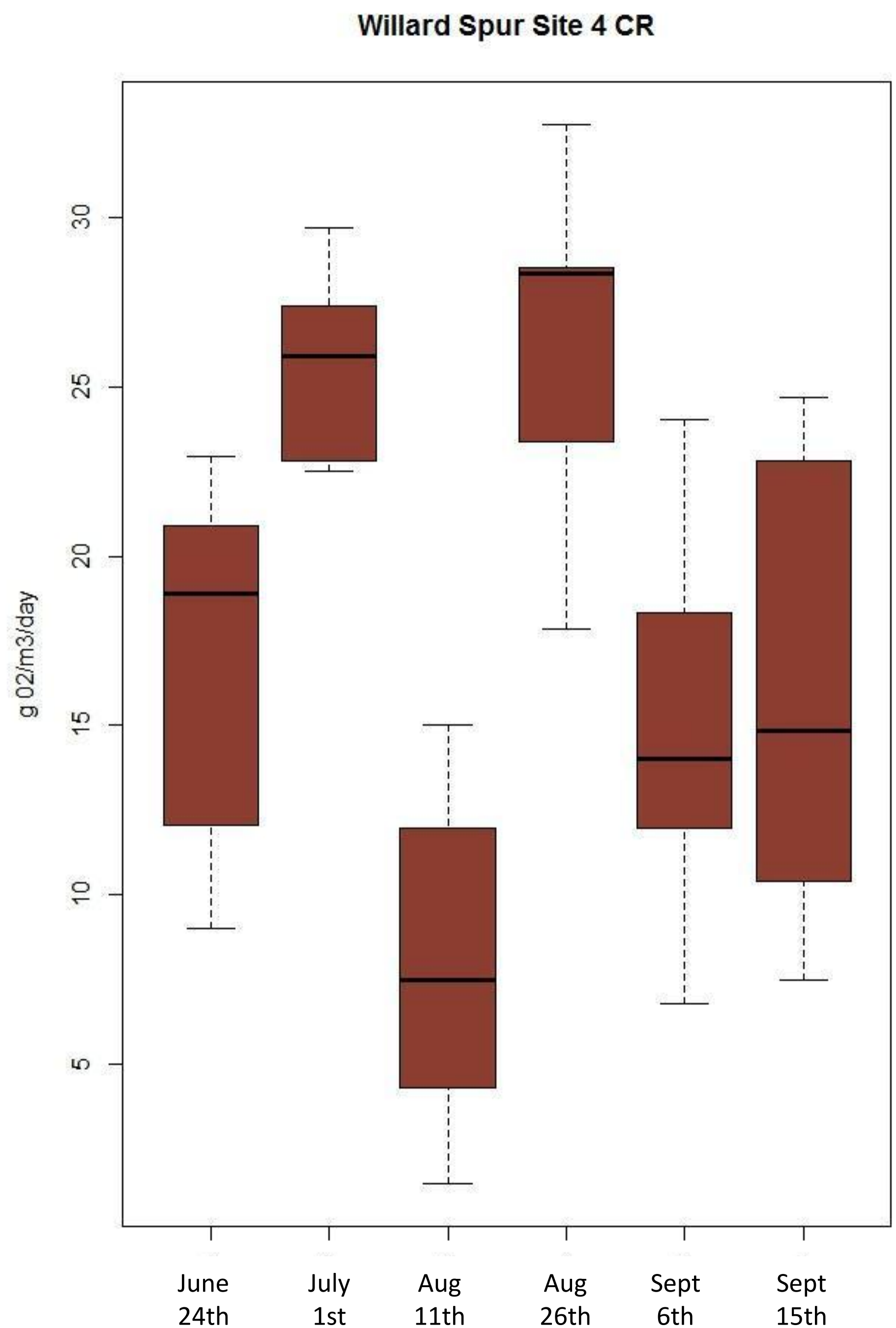

# 6. What Does it all mean?

Correspondence with physicochemical measures?

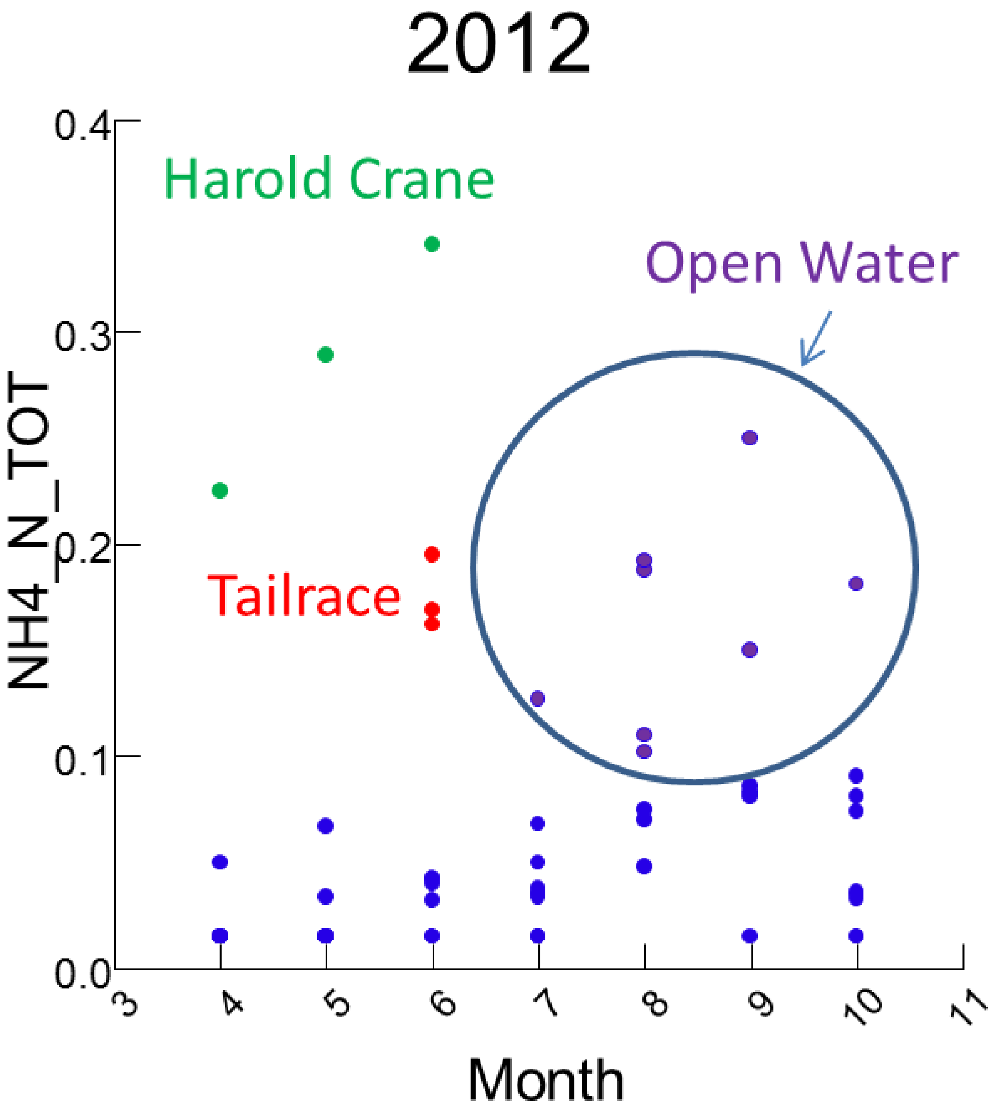



Willard Spur Site 4 GPP
g 02/m3/day
30
25
20
15
10
5
June
24th
July
1st
Aug
11th
Aug
26th
Sept
6th
Sept
15th

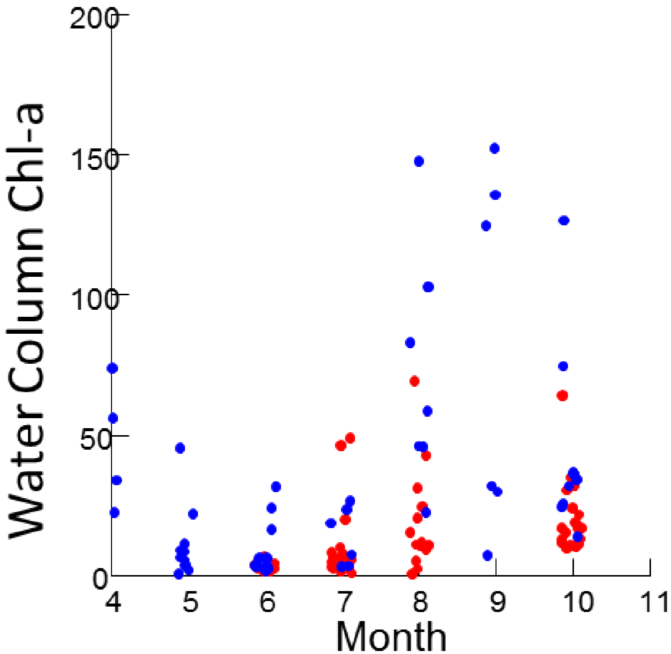

Willard Spur Site 4 CR
g 02/m3/day
30
25
20
15
10
5
June
24th
July
1st
Aug
11th
Aug
26th
Sept
6th
Sept
15th

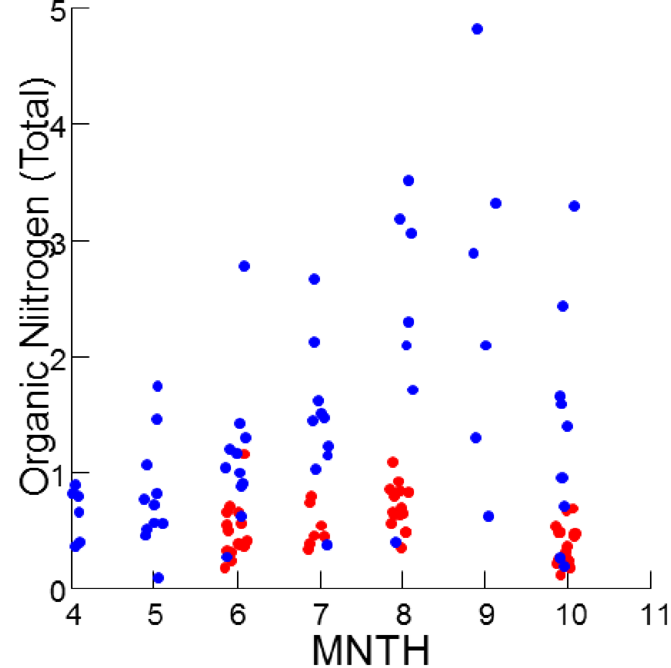
# Internal Cycling: Mineralization

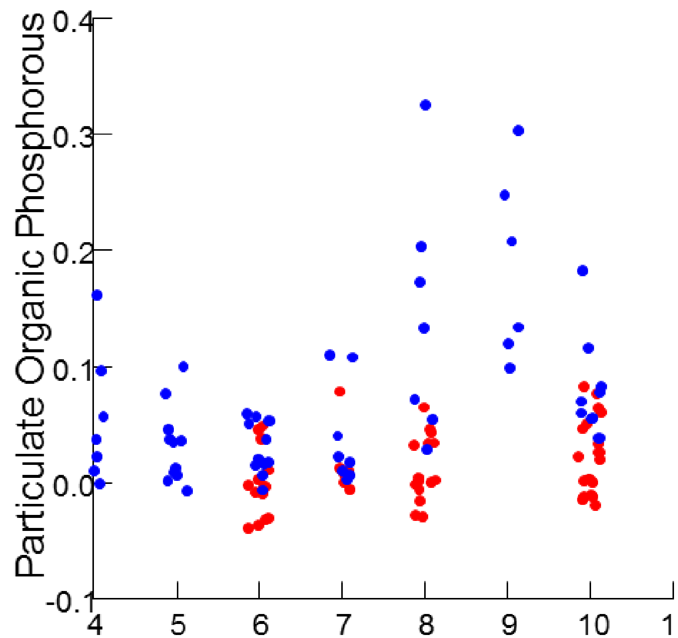



- DO Data in 2012 showed fairly long periods of anoxic conditions (<1 mg/l)
- Evidence of mineralization: ON to $NH_4$
- Change in nutrient limitation throughout the year?
- ***Reflects importance of internal nutrient cycling***: higher values, in more places after the Spur is mostly isolated.

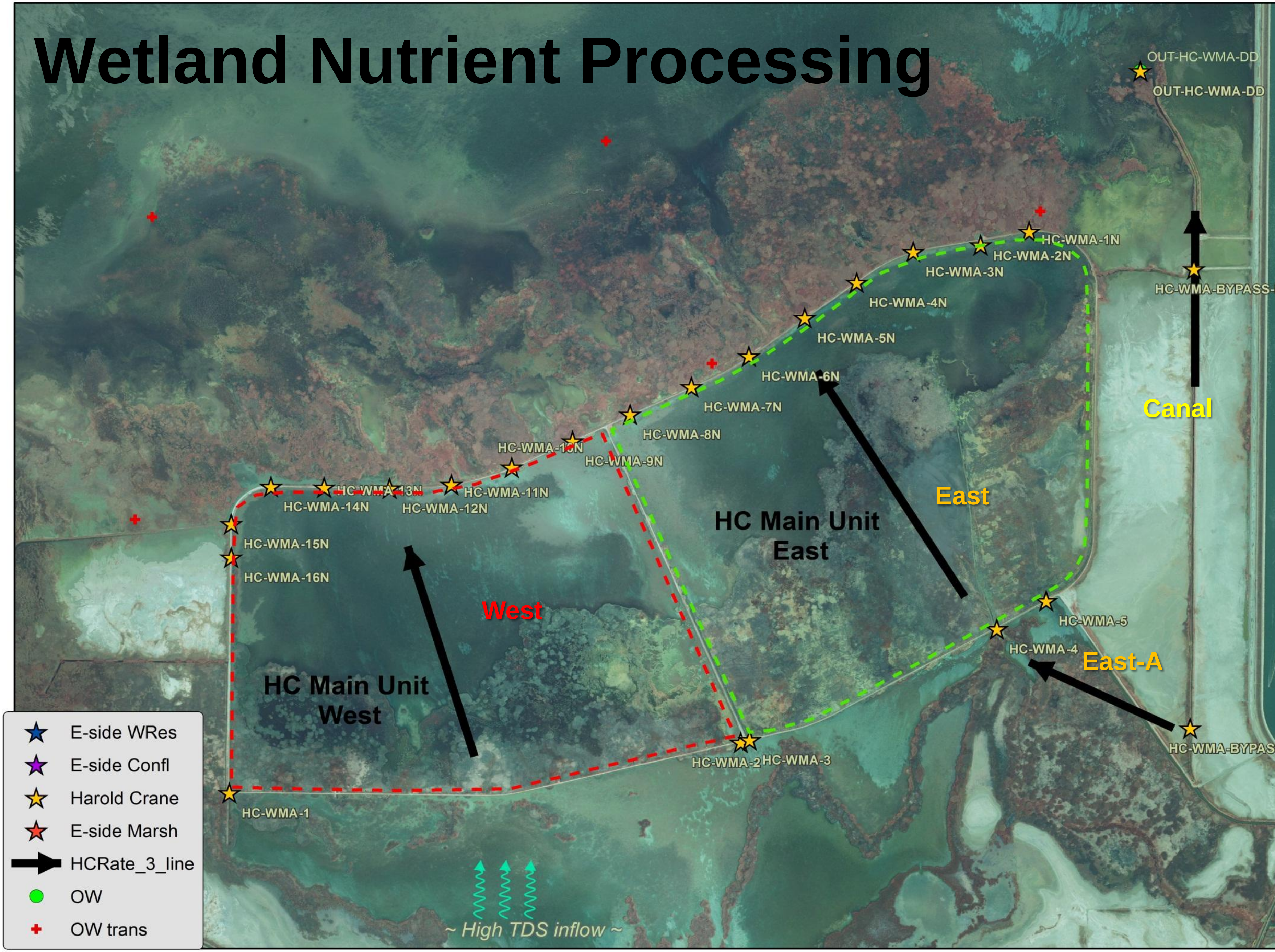
# Organic N & P


Water Column Chl-a
0
50
100
150
200
4 5 6 7 8 9 10 11
Month

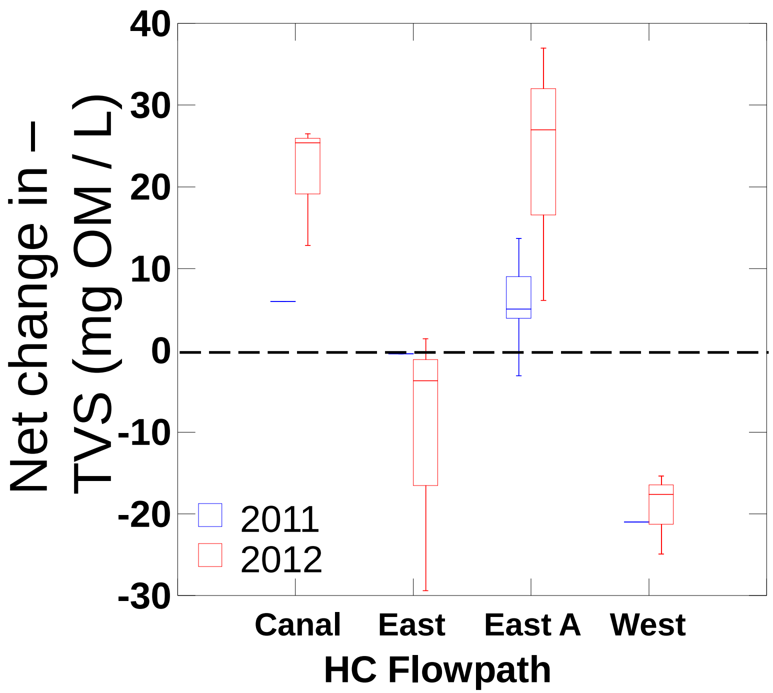

Organic Niitrogen (Total)
0
1
2
3
4
5
4 5 6 7 8 9 10 11
MNTH


Particulate Organic Phosphorous
-0.1
0.0
0.1
0.2
0.3
0.4
4 5 6 7 8 9 10 11

# Wetland Nutrient Processing



# Wetland Nutrient Processing



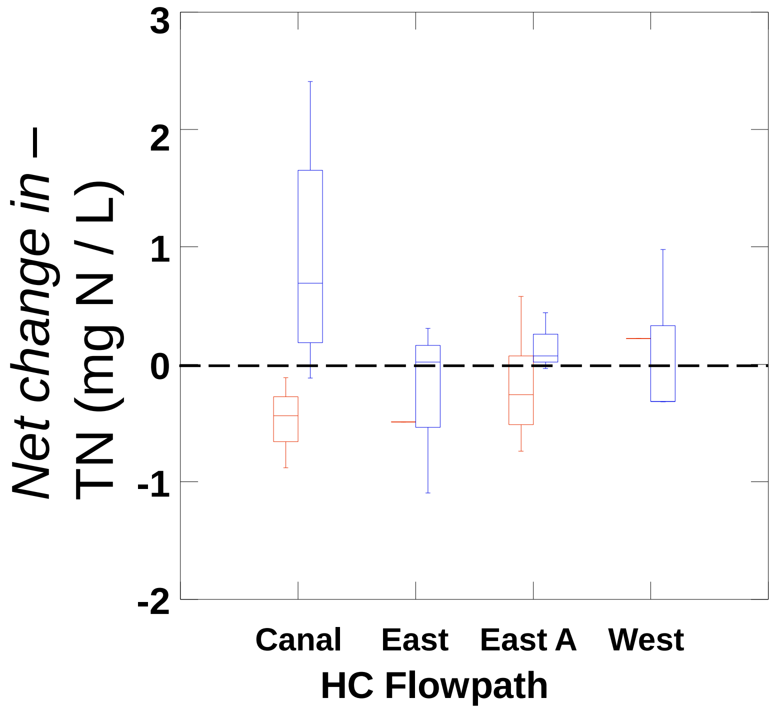

- Not real 'rates', calculated as conc. difference of Outflow – Inflow
  - X > 0 → net <u>gain</u> through wetland
  - X < 0 → net <u>loss</u> through wetland

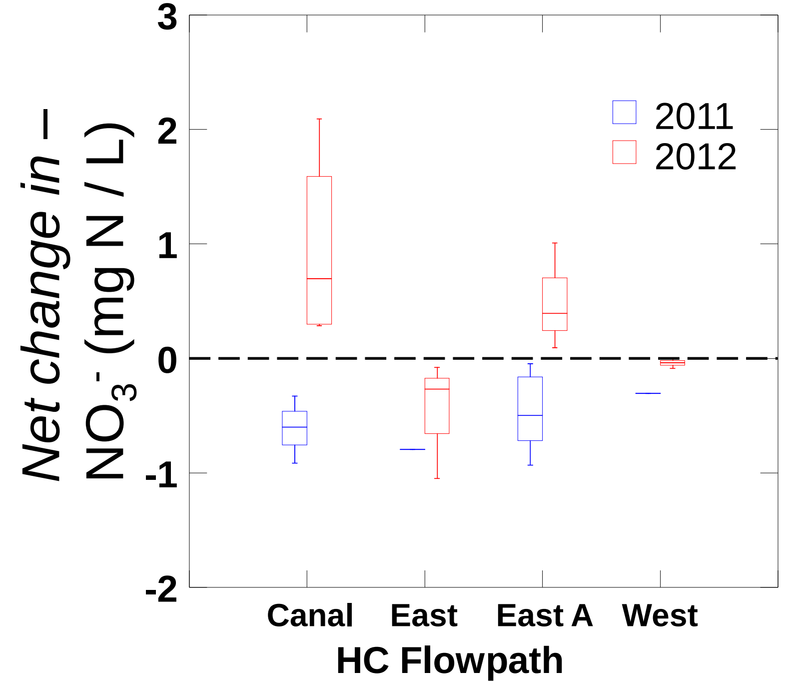
- For Total Volatile Solids (OM in TSS):
  - Both Canal and East-A (marsh) flowpaths showed net increase in suspended OM
  - Conversely, East and West impounded wetlands displayed net loss of suspended OM

<u>Potential issues</u>:

- Need to account for differences in hydraulics (retention time)
- For Organic C, have no measures of dissolved C or C removed via sedimentation

# Wetland Nutrient Processing



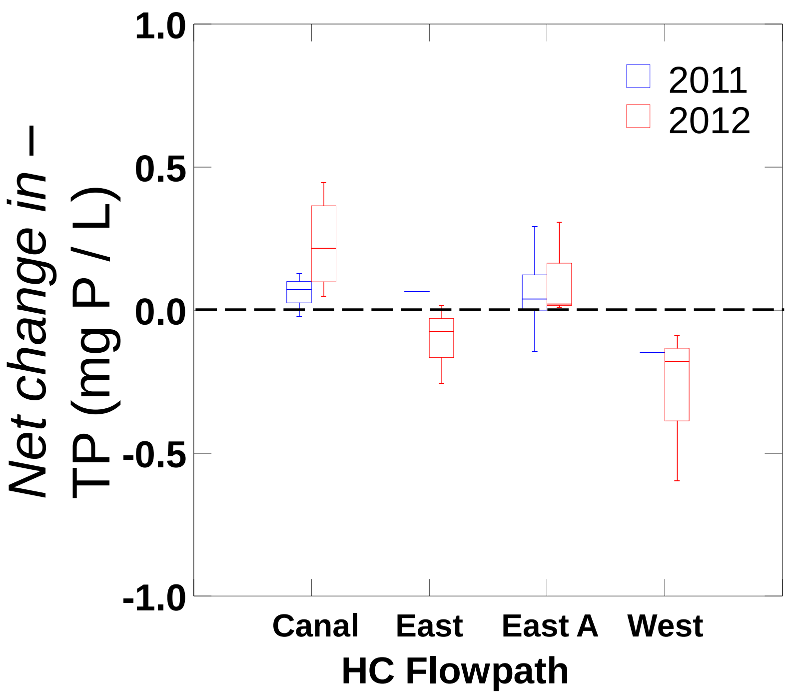

**Total N (TKN + $NO_3$)**

- Wetlands were generally balanced
- Similar for TKN
- Canal – net N source in 2011, and small sink in 2012

**Nitrate ($NO_3$)**

- In 2012, Canal and East-A (marsh) were net sources of NO3, but sinks in 2011
- Impounded wetlands (East, West) were sinks or balanced, respectively

# Wetland Nutrient Processing




- Canal – small to modest source of TP
- East-A (marsh) balanced to small source
- East and West impounded wetlands were modest sinks for TP

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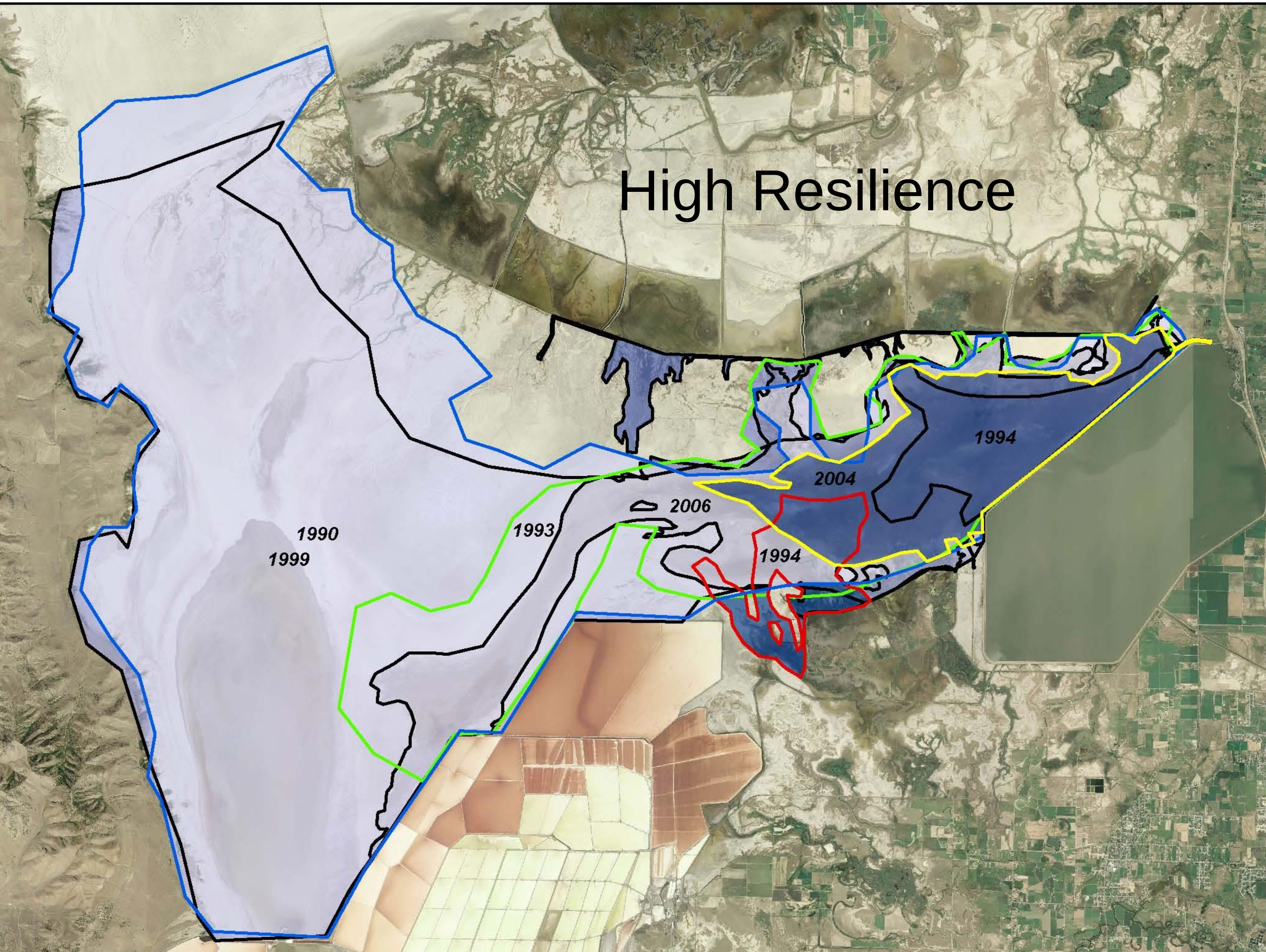
*Paired measurements provide mass-balance limits on net and gross rates of C and nutrient cycling*

Monitoring well-defined hydraulic and nutrient pathways:

- Provide estimates of net assimilation across large areas
- Context for smaller-scale measurements

    (e.g. trace gas, sediment, or water column fluxes)


High Resilience
1994
2004
2006
1993
1990
1999
1994

# Does the plant represent a threat to the Spur?

Probably not, at least immediately…

- Any effects—positive or negative—are small and local
  - Importance of local cycling vs. <u>all</u> external inputs
  - Size of discharge small relative to other sources
- Ecological resilience
- Any deleterious effects are <u>likely to be local</u>
  - i.e., rapid uptake of nutrients
- Yearly flushing flows <u>probably</u> decreases accumulation through time
- N-limitation thresholds suggest that were at ~50% assimilative capacity

  - but more work needed

# What is needed to ensure protection of the Spur?

## A Couple of Possibilities:

- Change use class: 3B with DO exception
- Develop long-term monitoring plan
  - look for local impacts and trends near the plant compared with elsewhere

## A Couple of Questions:

- Continue the plant continue with P removal?
- Possible to restore connectivity under lower water conditions?

# Next Steps: 2013 Recommendations and Rationale

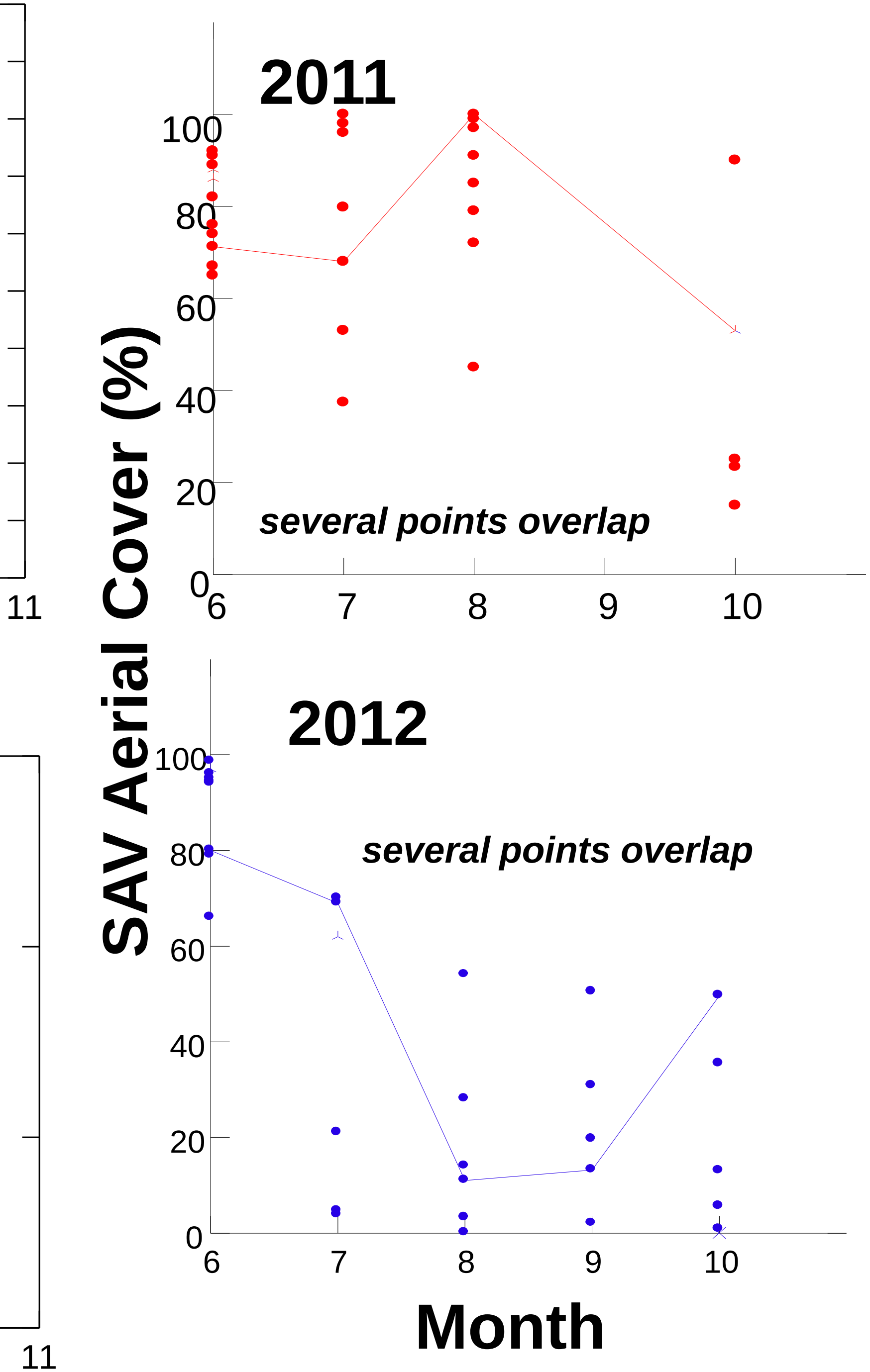
- **More Thorough Metals Analysis**
  - Cursory evaluation suggests no WQS violations

- **Sediment Analysis**
  - Internal processes & potential as integrative measure for long-term monitoring

- **Nutrient Uptake**
  - Quantitative extrapolation of the expected zone of influence for the discharge
  - Define expectations for future scenarios

- **Evaluate Importance of P to Microbial Processes**
  - Decouple respiration components
  - Ecological stoichiometry

- **Monitoring**
  - Scale back in 2013: fewer input sites,

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